Chapter 38

REPAIR OF MANDIBULAR BONY DEFECTS

JEFFREY A. FAULKNER, MD, DDS*

*Colonel (Retired), Medical Corps, US Army; Physician, Otolaryngology, 499 10th Street, Floresville, Texas 78114

INTRODUCTION

In contrast to the urgent nature of treatment within the combat zone, the decision-making related to timing of reconstruction for complex facial injuries at Role 4 facilities stateside is more comparable to that seen with civilian trauma. Once a patient has been evacuated to a medical center, that patient is usually stable, and treatment planning may proceed with less chaos. There are exceptions. For example, severely burned patients may be transported directly to the Department of Defense Burn Center at Fort Sam Houston and require a sustained period of physiological support before reconstructive surgery can be contemplated. This should not imply that the reconstructive task is similar to those seen for typical civilian trauma. In fact, the average facial fracture level of complexity caused by improvised explosive devices or high-velocity projectiles from mortars, rockets, and rifles is much higher. In these injuries, the regional vascularity has been compromised by multiple facial lacerations, and frequently the soft-tissue envelope has been severely abraded or burned.[1] The wound is typically a composite defect, and those factors complicate reconstruction with regional soft-tissue flaps.[2] If the fractured mandible cannot be reconstructed immediately, it is critical to at least cover the exposed bony fragments with soft tissue to maintain the health of the remaining bone. If the blood supply to the surrounding soft tissue has been compromised by lacerations and the skin is burned, then regional transposition of soft tissue may not be possible. In addition to the potential compromise of local and regional soft tissues, many of these combat trauma patients will have suffered extremity injury or amputation, thus limiting the options available for vascularized free tissue transfer. One can imagine the reluctance of a patient to commit to taking the fibula from his only remaining leg.

LATE STABILIZATION

After the patient has been evacuated to the Role 4 stateside facility, there is still some physiological stabilization that must occur. Extremity wounds and abdominal wounds may need multiple daily "washouts." Brain injury may require additional surgical intervention, or time may be required to allow cerebral edema to resolve itself prior to elective reconstruction. Burns may require intensive surgical and medical therapy, thus demanding the postponement of reconstructive surgery. As the patient recovers during this period of late stabilization, the reconstructive surgeon should address wound bed preparation.

WOUND BED PREPARATION

The best results will occur if bony surfaces are covered with soft tissue, the oral mucosa has a watertight seal, and the bony framework of the mandible is maintained in its normal physiological position. Placing the mandible into "normal occlusion" with a composite defect is challenging and may require a combination of arch bars, external fixators, and reconstruction plates. If the mandible is allowed to heal into an abnormal position, reestablishing the normal relationship later will be much more difficult. Another important consideration is to allow the mandible to function. If the mandible is held immobile for more than 10 days and there has been a condylar injury, the likelihood of trismus increases dramatically. Reconstructing a mandible with bone grafts and vascularized free tissue poses enough difficulties to normal function without the additional complication of trismus. Trismus will also interfere significantly with the secondary reconstruction of occlusion. If the dentist or prosthodontist cannot gain access to the oral cavity to provide a functional prosthetic or implant, there may be a cosmetically pleasing reconstruction that is a functional failure. In Chapter 26, Mandible Fractures, a case study report describes the immediate treatment of a Marine with severe facial burns. His management was delayed because of those burns. The comminuted mandible fracture was stabilized with arch bars. Because of extensive burns, his definitive treatment was delayed. The contracture of the burned facial skin caused the comminuted symphysis to contract as it healed, thus requiring a sliding osteotomy for repair. The long period of intermaxillary fixation combined with bilateral condylar fractures resulted in bilateral ankylosis of the temporomandibular joint requiring bilateral rib grafts for mobilization. To date, this patient has required 115 surgeries.

Getting soft-tissue coverage is also essential to maintain the viability of the remaining bony segments and may require local or regional transposition flaps to achieve adequate coverage (Case Study 38-1).

DONOR SITE SELECTION

Amputation, vascular compromise, and burns may limit donor site selection. For smaller mandibular defects, a free graft of homologous cortical and cancellous bone can be harvested from the iliac crest or the tibial plateau. Those grafts require a healthy recipient bed without infection or fistula and a watertight oral mucosa. The bony fragments must be stabilized in the recovery period. The postoperative morbidity resulting from the tibial plateau graft is less than the morbidity from the iliac crest graft, but more bone can be harvested from the iliac crest.[3–6] Although there are several vascularized osteocutanous free graft options, the two most common are the fibula and the iliac crest. The fibula is less bulky than the iliac crest; has a longer pedicle; and can transfer muscle, skin, or both.[7,8] There are studies suggesting that the fibula free flap has a better functional result, but the fibula may not be able to provide enough bone for larger defects.[9,10]

PRIMARY RECONSTRUCTION

For mandibular reconstruction, thought must be given to the potential for an adequate secondary reconstruction with either a prosthetic dental appliance or dental implants. The bone positioning and height should be sufficient for dental implants. Achieving the proper height with a single fibular strut may require situating the graft in a superior position in the defect. Getting the proper alveolar height is critical for the function and cosmetics of a dental prosthetic. If the bone flap is placed too low, the crown-to-height ratio of the dental implant will be increased. The increase in the crown-to-height ratio increases the lever arm applied to the implant. That increased lever arm can result in a lateral load on the implant that is unfavorable for long-term retention and cause eventual loosening and loss of the implant. Conversely, if a bony flap is placed in a superior position in the defect, the lack of bony support for the mentalis can leave a deficit in the prominence of the chin resulting in a poor cosmetic result. The ideal flap would provide sufficient alveolar height, as well as bony support, for the lower face. Some surgeons have overcome this potential drawback of the fibular flap by placing a double strut. Creating a double strut with the fibular flap will shorten the pedicle length and can pose some technical difficulties with placement, but has proven to be successful.[11,12] Other surgeons have used distraction osteogenesis to enlarge the bony graft to fill a bony defect without grafting. This involves a second surgical procedure after the graft has healed. A sliding osteotomy incision is made in the bony implant, and a distraction device is attached to the inferior and superior segments. Over the next few weeks, the two segments are distracted from each other by daily rotation of a screw. When the final height is achieved, the segments are held in position to allow complete bony healing. The distraction device is removed, and implants can be placed in the neoalveolus. This technique has the added benefit of bringing the soft tissue along with the bone as the alveolus is enlarged. This concept is being applied to a variety of craniofacial abnormalities as well.[13–16]

Vascularized composite allografting expands the versatility of vascularized free tissue transfer and is very useful for composite defects. The composite graft is "built" over the vascularized free flap, and once neovascularization has occurred, the entire complex is transferred to the defect. Two surface defects can be prelaminated with mucosa or with hair-bearing skin and transferred as one unit.[17,18] Finally, the field of tissue engineering is exploring novel techniques to restore lost tissue to include bone and cartilage. As the field develops, this option may be considered a potential alternative in the reconstructive plan for patients with extensive injury.[19,20]

SECONDARY RECONSTRUCTION

When planning reconstruction of the mandible that involves a composite graft of bone, consideration should be given to the functional outcome, as well as the cosmetic outcome. The bone grafted into the defect should be sufficient in bulk to either provide sufficient bone for dental implants and consequent dental rehabilitation, or the bone should provide an adequate alveolus to support a removable dental prosthetic. If the defect will be spanned by a fixed prosthetic that is supported on either side by native teeth, it is ideal to have a bony alveolus of sufficient height to simulate a natural alveolus so that the replacement teeth are of normal length.[21,22]

Even in cases where the height of the graft is not equal to the height of the surrounding bone, adequate prosthetic rehabilitation can be accomplished using a variety of techniques, such as an implant-borne denture and implant-retained denture.[23–25] These

techniques use the osseointegrated implants to retain or stabilize the acrylic prosthetic. The prosthetic distributes the forces of mastication across the bone graft, native mandible, and native teeth. The acrylic base of the prosthetic, when properly constructed, restores the normal contour and height of the alveolus, thus providing a cosmetically pleasing and functional result. See Case Study 33-1 in Chapter 33, Preoperative Planning for Delayed Head and Neck Surgery, for a thorough discussion of the considerations necessary for successful dental rehabilitation using implant-supported dental prosthetics.

SUMMARY

Severely comminuted and avulsed mandible fractures resulting from combat injuries often cause extensive composite tissue loss. Restoring form and function can be challenging and require multiple operations and creative surgical solutions. Vascularized free flaps provide a reliable, versatile solution for complex mandible fractures especially when combined with thorough dental rehabilitation.

CASE PRESENTATION

Case Study 38-1

Presentation

An Iraqi woman in her forties was injured by mortar fire. Damage control measures were taken in the field, and she was intubated transorally (Figure 38-1). She was evacuated directly to Balad Air Base with massive facial injuries, abdominal injuries, and extremity injuries. She was taken to the operating room following an expedited radiological workup of a full-body CT (computed tomography) scan.

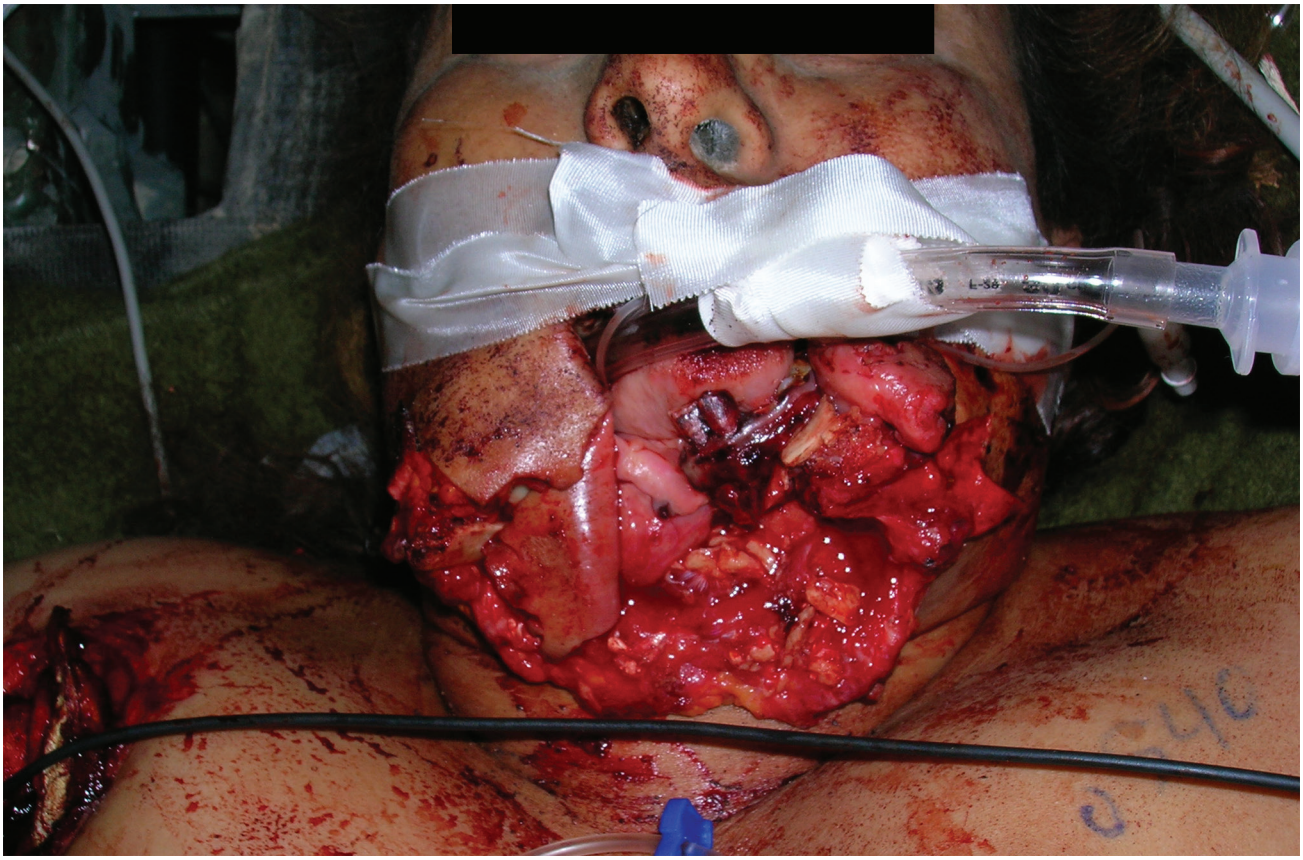

Figure 38-1. Preoperative photograph of patient intubated transorally in the field.

Preoperative Workup/Radiology

Because of the extent of her injuries, the workup was brief, including only physiological stabilization and a rapid, full-body CT scan. The CT scan of the face showed avulsion of the entire symphysis of the mandible from bicuspid to bicuspid (Figure 38-2).

Operative Planning/Timing of Surgery

Reconstruction was staged. The first operative goal was stabilization of the patient and preparation of the wound bed. The patient was stabilized with a tracheotomy, fixation of the bony fragments in what remained of the normal occlusion, and coverage of the fragment. Following that, reconstruction was planned using a fibula-free flap with osteotomies to allow for normal curvature of the symphysis.

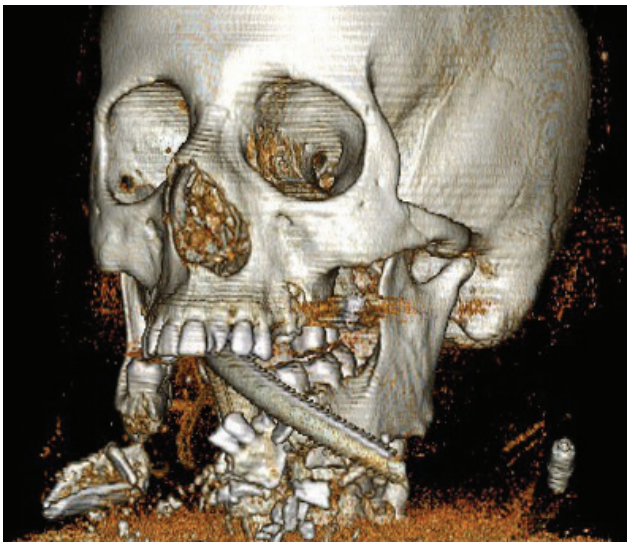

Figure 38-2. Three-dimensional reconstruction of CT (computed tomography) face showing avulsed mandibular symphysis.

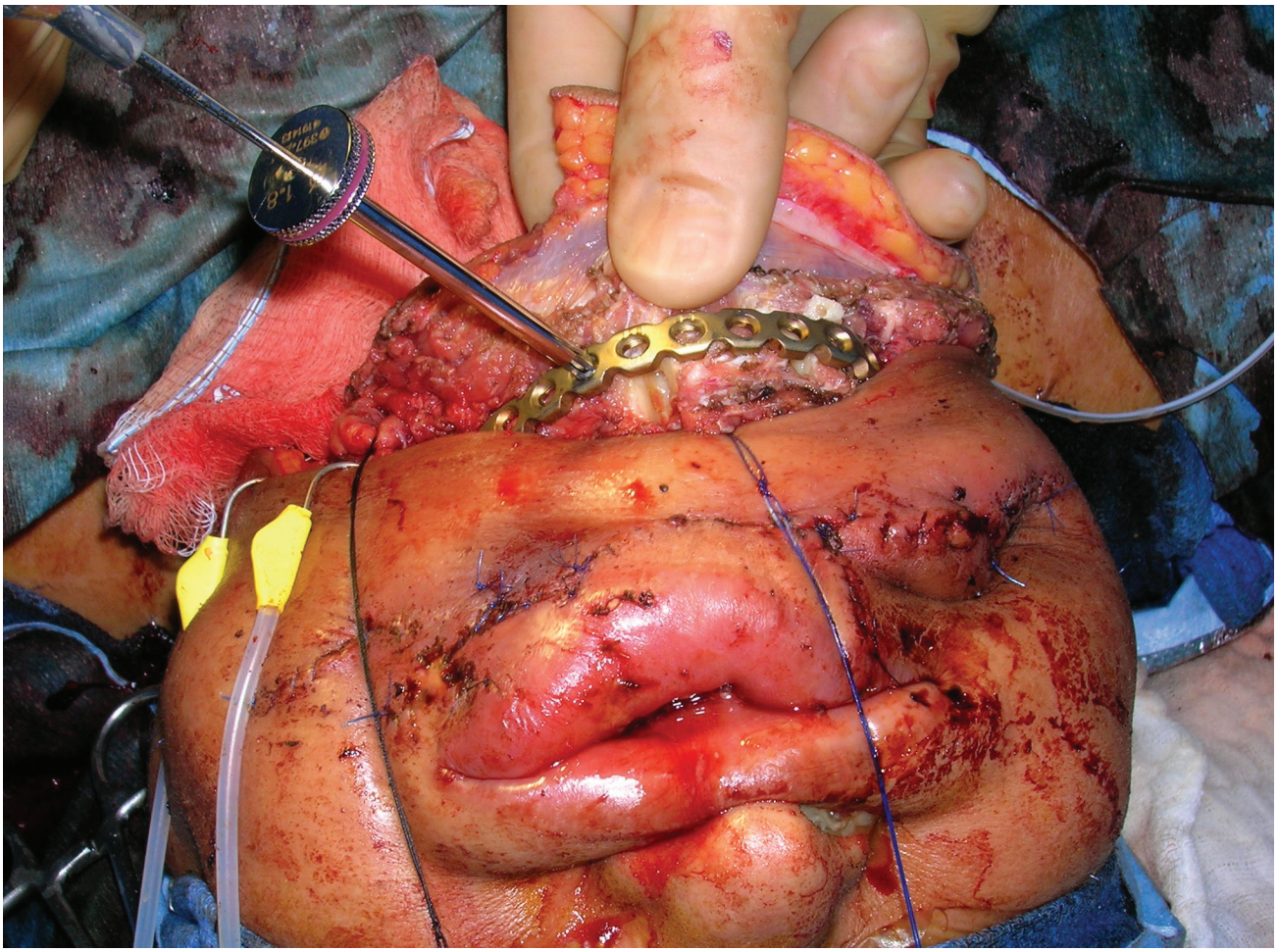

Figure 38-3. Fibula-free flap in position.

Operation

After 1 week, the patient was stable enough for definitive surgery and was taken to the operating room. The fibula was chosen because it provided sufficient bone for reconstruction, had a long pedicle, and allowed two surgical teams to operate simultaneously. The mandible was approached transcervically, thus exposing the bony remnants of the mandible and the reconstruction plate. The cervical skin was mobilized superiorly to accommodate the loss of soft tissue at the mentalis. The osteocutaneous fibula graft was measured to fit the defect, and multiple wedge osteotomies were performed to allow the graft to conform to the curve of the reconstruction bar. The graft was fixed in position with bicortical screws (Figure 38-3). The skin paddle filled the defect created by mobilizing the cervical skin superiorly and was available for monitoring the viability of the graft. A watertight closure was achieved, and the patient was allowed to recover.

Complications

The patient did well in the immediate postoperative period with good graft viability and resolution of postoperative edema. But approximately 1 week following surgery, she succumbed to a pulmonary embolism and died.

Lessons Learned

This case illustrates the potential for free flaps to reconstruct defects that cannot be restored as well with any other technique. It also presents some serious reservations concerning providing this sort of service in the combat zone. There was opposition to performing any free flap in our hospital because of the amount of operating room time and postoperative recovery time. During that period of the war, the daily life of an Iraqi civilian was fraught with danger, and the loss of mobility could be life-threatening. Most of the free flaps that we performed were in an effort to prevent the amputation of an extremity in an Iraqi soldier or civilian. Although we recognized the valid concerns for conservation of resources, we also tried to provide the Iraqi patients with the same level of care that our coalition soldiers would receive and were able to convince the trauma chief to allow the procedures. It was discouraging to put so much effort into the reconstruction of this patient and then to lose the patient when recovery seemed assured. We did not perform free flaps in the combat zone on military members from the United States because those patients had that treatment available to them once they were evacuated from the combat zone; therefore, it could not be justified.

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